Small series of both *Eurema dina westwoodi* and *nise perimede* in the Stallings-Turner Collection indicate that they are subject to similar seasonal variation; the series available, however, is too small to describe the unnamed forms.

Field described a female form of *Eurema nicippe* under the name of *callae*. We have not been able to examine the type but from the description are of the opinion that this is a phase five, or extreme winter form and hence a synonym of *nicippe*. We suggest that form *clappi* (Maynard) of *Eurema lisa* is likewise a phase five, or extreme winter form and hence a synonym of *lisa*.

(*To be continued*)

PERSONAL

Dr. Guy F. MacLeod, professor of entomology at the University of California, has been appointed chief of the chemicals and fertilizer branch of the Chemical Division of the War Food Administration.

A Summary of the Mormon Cricket (Anabrus simplex) (Tettigoniidae: Orthoptera)

By Ira La Rivers, Bremerton, Washington

A considerable fund of information concerning the biologics and economics of the Mormon cricket (*Anabrus simplex* Haldeman) has accumulated in recent years in widely-scattered journals throughout the country, and I have thought it expedient to review the essential features of the more important of these papers for the sake of unification and clarity, as well as to add certain hitherto unpublished aspects of the problem.

The 1848 "cricket war" in the Great Salt Lake valley was the first record of this species' destructive capabilities, and it has periodically appeared in many surrounding states since then. The total distribution of the species embraces nearly all the western United States, viz., Washington, Oregon, California, Idaho, Nevada, Montana, Wyoming, Utah, Colorado, New

Mexico, North and South Dakota, Nebraska, Kansas, Minnesota and adjacent Canada. It is not, fortunately, of economic importance over the entire area of its occurrence, but in 1939, ten states had found it of sufficient importance to attempt control measures, with the aid of the Federal Government.

While there have been many infestations of local importance, the major outbreaks have occurred in Utah (Great Salt Lake valley, 1848–1850; Duchesne and Uinta Counties, 1923–1926), Idaho (various districts in southern Idaho, 1872, 1883, 1894, 1904, and 1932–1940), Nevada (Tuscarora, Elko County, 1878; Pine Valley, Eureka County, 1882; Diamond Valley, Eureka County, 1886; Cortez area, Lander County, 1900–1904; Elko, Humboldt, Eureka, Lander, and Pershing Counties, 1932–1940), Colorado (northwestern section, 1879, 1882, 1895, 1900, 1902, 1905, 1924–1928, and 1928–1931), Wyoming (Hot Springs County, 1923–1925; various districts in the state, except the southwest sector, 1932–1938), Montana (Carbon County, 1923; Lake and Sanders Counties, 1924–1928; southeastern section, 1932–1940), North Dakota (southern portion, 1932–1940), South Dakota (central portion, 1932–1940). Cooperative Federal, State, and County efforts must be exercised in any satisfactory system of control. At the present time, the species is pandemic over a wider area than at any other time in its recorded history.

Present-day control methods are reasonably satisfactory when the infested country is such that modern, efficient machinery can be used, as power dusters and airplanes. Rough, rocky terrain requires the use of slower, less comprehensive hand dusters with a consequent loss of killing power. Districts with well-ditched sections advantageously situated for the use of oiling further increase the efficiency of known control methods. Level or rolling country in which crickets are moving as bands is suited to the erection of tin barriers to reflect the marching insects into traps of various types where they may be dusted, burned, or merely left in the hot sun, which quickly kills them.

The first efficacious dusting mixtures were developed by Shotwell and Cowan for use in Montana field work (1926) and

consisted of one part sodium arsenite to four parts hydrated lime, and one part calcium arsenite to three parts lime, with a recommended application of five-to-seven pounds per acre for the former and eight pounds for the latter, depending upon cricket concentration. The latter compound has been largely discarded in favor of the more toxic sodium arsenite, and cheaper diatomaceous earth has been substituted for lime, which is irritating to human skin. It is a relatively simple matter to mix the ingredients, which are then delivered with power and hand dusters; assuming the topography of the country to be suitable for power duster use, hand dusters are still valuable supplements especially for spraying early morning concentrations of crickets where they have spent the night clustered under, and in, sagebrush (*Artemisia tridentata*), etc., and along rough coulee and cañon bottoms.

Successful oil barriers require irrigating ditches, canals, or streams upon which the oil can be spread, and are an excellent control method under these conditions. A thin, low-grade distillate has been found most satisfactory, since it flows freely, spreads rapidly and smoothly, and forms a uniform, thin film. Just enough need be used to form the thinnest film on the water's surface, and when used correctly, neither disqualifies the water for human consumption nor for irrigation purposes. Oil can be retained in the main ditch by baffle boards or underwater delivery boards, which prevent it from entering secondary ditches; when present in moderate excess, however, it does no harm to plants or livestock, merely acting as a laxative to the latter. It kills crickets by enclosing them in an oil film through which they cannot breathe.

Metal barriers most successfully used are ten- and twelve-inch strips of 28-gauge galvanized sheet iron in 50- or 100-foot rolls. These are erected across the crickets' line-of-march, care being taken to clear the ground before the barrier so the brush does not overlap, and to keep the supporting pegs well below the level of the barrier so these cannot serve as ladders for the animals to climb over. Traps of various types must be utilized with metal barriers, and may be pits in the ground, or traps formed

by making large corrals of the galvanized sheeting out of which crickets cannot climb.

Baiting has proven as unsatisfactory with crickets as it has been successful with grasshoppers.

Those first interested in the biologics of the Mormon cricket were undoubtedly the American Indian (Amerind) tribes who used the insect for food. From reports of early pioneers, these included principally those tribes of Shoshoni origin and probably all Ute tribes of southern and eastern Utah and adjacent parts of Colorado, as well as the Bannocks of southern Idaho. The Northern Piutes bordering the Shoshonis on the west and occupying western Nevada, southeastern Oregon and portions of southwestern Idaho likewise feasted on insects on occasion, but the Southern Piutes were too far south to have come in contact regularly with epidemic cricket bands. Crows, Flatheads, and Nez Perce, although occupying areas of large cricket populations, evidently did not exist in the extreme poverty which usually characterized Amerinds of the Great Basin area generally, so probably did not require such items as insects in their diets. Early Mormon accounts of the use of the cricket as food by local natives (probably Weber Utes) tell of the Amerinds seining the insects from streams with baskets especially constructed for such work, sun-drying and roasting them for future consumption (Hendson 1931). In a region where many of the tribal groups were forced to subsist on lizards, roots, pinenuts, etc., the appearance of thousands or millions of large crickets must have been regarded by them with satisfaction, although most readers of this would face the prospect of such a meal with extreme repugnance.

The Mormons of 1848 were the first whites with reason to be interested in the large black crickets, and made many impromptu observations on the species' life history. In 1850, Captain Howard Stansbury led a United States Government expedition to explore the valley of the Great Salt Lake and to collect such biologic items, at the request of S. F. Baird, Smithsonian Institute secretary, as the party could while conducting their survey. Among the specimens returned to Washington was one largely

legless, adult tettigoniid which Prof. Haldeman described as *Anabrus simplex* because of its unprepossessing appearance. Haldeman said of it in the report of the expedition published in 1853: "A single specimen was brought from the Valley of the Great Salt Lake. . . . This seems to be one of the species eaten by the aborigines of the Valley. . . ." No mention was made of the species as a destructive agent, and it is clear that neither Haldeman nor Baird suspected this wingless cricket to be the "plague" insect of 1848, for in describing a new oedipodine from the same region (*Oedipoda corallipes*), Haldeman said: "This fine large grasshopper is probably the species which has been destructive to vegetation in the Valley of the Great Salt Lake" and Baird clearly indicated beyond doubt that he shared the misconception by the introductory statement that "The principal entomological result" (of the expedition) "is the precise determination of the destructive grasshopper, which, but for the interposition of a species of tern, at one period was near turning the 'Garden of the mountains' into a desert." It is not printed, to the author's knowledge, when the true status of *Anabrus simplex* became established. It is certain the error was corrected soon afterward.

In 1931 Henderson, assuming the inviolability of the common name, in discussing the original error stated "For Baird to be correct about having the right species in mind it must be clear that he should have said 'cricket' instead of 'grasshopper.'" On this basis alone, it would not be entirely safe to evaluate such a statement by an elder naturalist since entomologists in general have not, in the printed word, made quite the distinction between crickets and grasshoppers as Henderson has the logic to make; in fact, the majority of publications including the tettigoniids usually call them crickets and apologize immediately in parentheses or a footnote that they are, after all, "long-horned grasshoppers instead," to differentiate them from the Locustidae, or short-horned grasshoppers. As may easily be verified by a study of the groups involved, the Tettigoniidae are more closely allied to true crickets than to grasshoppers, and it is begging

the question to call them "long-horned grasshoppers." In this case, the use of the common name shows better judgment.

Gradually more information accumulated, but organized official action was not taken in the matter of control until the turn of the 20th century; in 1902 the University of Nevada Agricultural Experiment Station undertook preliminary field work in northeastern Nevada in an effort to control an outbreak in Starr Valley, but little constructive information accrued from this work (Doten 1904). Similar work was carried on, about the same time, by the Idaho (Aldrich 1904) and Colorado (Gillette and Johnson 1905) Experiment Stations. Desultory official recognition persisted until the early 1920's, when Colorado state entomologists began contributory work on life history and control, publishing three bulletins on the results of their research between 1920 and 1930. Progress followed rapidly, culminating in Cowan's admirable investigations in Montana in 1926 and 1927 (Cowan 1929) in which, for the first time, the essentials of the animal's life history and satisfactory control measures were worked out and successfully applied in the field. During the 1930's, several state and Federal bulletins were published on the economics of the cricket, each contributing a little more to the growing fund of knowledge.

Interest was turning to the less immediately applicable economic aspects of the problem, such as the possibilities presented by biological control. Isolated observations on certain elements of this complex had been made and published from time-to-time in economic bulletins. Cowan's bulletin (1929) was the first to bring together any significant amount of this type of information in detail, and gave the first preliminary account of the most important of the crickets' parasites and predators. He gave a preliminary list of the birds which fed on the cricket, listing 19 forms representing ten families. This was a summation of what had accumulated up to that time. In 1939, the number of birds known to feed on the animal was raised to 37, distributed among eighteen families (La Rivers 1941). In addition, Cowan mentioned some common mammals in passing, and a section was devoted to the principal parasites. At that

time it was known that the crickets' eggs were attacked by a tiny scelionid wasp *Sparaison pilosum* Ashmead, which had been seen to so reduce the yield of several western Montana cricket eggbeds that no control was necessary the following season. Then, as now, this wasp was considered potentially the most important of the crickets' parasites, but to date (1943) no further detailed knowledge of the possibilities presented by this phase of the problem has accrued.

A more conspicuous parasite of the cricket is the much larger black cricket wasp, *Chlorion laeviventris* (Cresson), which has a less noticeable effect in reducing the crickets' numbers, but which, nevertheless, is a factor. The details of this species' parasitization were only generally outlined by Cowan, since uncorrelated field observations formed the only basis for the known facts.

(*To be continued*)

Mounting Mosquito Larvae

In the issue of *Science* for March 10, 1944, Captain W. W. Middlekauff described a method of preparing slides of mosquito larvae by dehydrating in ethyl alcohol, clearing in creosote and then mounting in Canada Balsam. The method is not entirely new but is excellent for rapidity, ease and permanence.

Current Entomological Literature

COMPILED BY THE EDITORIAL STAFF.

Under the above head it is intended to note papers received at the Academy of Natural Sciences of Philadelphia and the University of Pennsylvania, pertaining to the Entomology of the Americas (North and South), including Arachnida and Myriopoda. Articles irrelevant to American entomology will not be noted; but contributions to anatomy, physiology and embryology of insects, however, whether relating to American or exotic species will be recorded.

This list gives references of the current or preceding year unless otherwise noted. Continued papers, with few exceptions, are recorded only at their first installment.

For records of Economic Literature, see the Experiment Station Record, Office of Experiment Stations, Washington. Also Review of Applied Entomology, Series A, London. For records of papers on Medical Entomology, see Review of Applied Entomology, Series B.

NOTE: The figures within brackets [ ] refer to the journal in which the paper appeared, as numbered in the List of Journals given at the end of the literature. The number of the volume, and in some cases, the part, heft, &c. is followed by a colon (:). References to papers containing new forms or names not so stated in titles are followed by (*); if containing keys are followed by (k); papers pertaining exclusively to Neotropical species, and not so indicated in the title, have the symbol (S).

Papers published in ENTOMOLOGICAL NEWS are not listed.